

# AN INVESTIGATION OF SURFACE WATER/GROUND WATER INTERACTIONS GREAT SAND DUNES NATIONAL PARK AND PRESERVE

National Park Service  
U.S. Department of the Interior



## Introduction

During September 22, 23, and 24, 2004, a seepage investigation was conducted on Deadman Creek, Sand Creek, Big Spring Creek, and Little Spring Creek in and adjacent to Great Sand Dunes National Park and Preserve (GRSA) in order to determine discharge, identify stream reaches where the stream was "gaining" or "losing" discharge, and to further understand surface water/ground water interactions at GRSA.



## Study Area Setting

**Location**  
The study area is located in the northeast end of the San Luis Valley (SLV), Colorado, north of the Rio Grande River, in the area known locally as the Closed Basin.

**Climate**  
Average annual precipitation at Medano Pass in the Sangre de Cristo Mountains is 28.9 inches (USDA, NRCS, 2006). Average annual precipitation at the GRSA Headquarters and the City of Alamosa is 11.1 inches and 7.07 inches respectively (USDOC, NOAA, 2006).

The annual pan evaporation for San Luis Lakes, Colorado, is approximately 56 inches (WRCC 2007).

**Surface Water**  
The hydrologic setting of GRSA encompasses the entire hydrologic cycle for the streams that exist there.

Deadman Creek and Sand Creek originate as precipitation in the Sangre de Cristo Mountains, at elevations up to about 13,600 feet amsl. As the streams emerge from the mountains they flow across alluvial fans, the "sand sheet" deposit, and into the "sabhka" and playa lake system near the center of the Closed Basin at an elevation of about 7,500 feet amsl.

Big Spring Creek and Little Spring Creek originate on the lowermost extent of the sand sheet where the land surface intercepts the ground water. Ground water sapping has caused headward erosion of the streams, extending the springline several miles up gradient and into the sand sheet.

Water from all streams that terminate in the Closed Basin leaves the system primarily through evapotranspiration.

**Ground Water**  
The shallowest aquifer in the SLV, the unconfined aquifer, is composed primarily of unconsolidated sands and gravels of Quaternary age ranging from about 60 feet thick to several hundred feet thick in the study area. The unconfined aquifer is thickest along the mountain front where the alluvial fans are over 500 feet thick; however, some of the alluvial fan is unsaturated (HRS, 2006). Below the layer of Quaternary sands and gravels is a layer composed primarily of lacustrine sediments dominated by clay layers that act as an aquitard and separate the unconfined aquifer from the confined aquifer in the Closed Basin (HRS, 2006). It is not known if the clay layers extend to the mountain front of the Sangre de Cristo Mountains, and as a result, surface waters that infiltrate into the alluvial fans or sand sheet along the mountain front may recharge both the unconfined and confined aquifers (Figures 1 and 2).

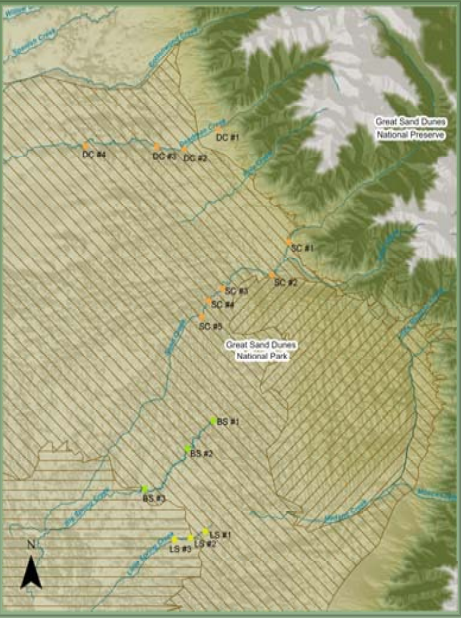


Figure 1.

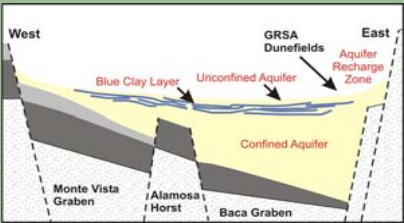


Figure 2.

## Methods

The seepage investigation consisted of discharge measurements made simultaneously at multiple cross sections along a given reach of stream. Discharge measurements were made using Pygmy current meters except for the measurements at Big Spring Creek #1 (BS#1), which were made with a portable 3-inch Parshall flume.

## Results and Discussion

### Deadman Creek and Sand Creek

From upstream to downstream along the 6.2-mile measured reach of Deadman Creek, the average discharge decreased from 8.4 cfs to 1.4 cfs and the average discharge along the 4.9-mile measured reach of Sand Creek decreased from 13 cfs to 0.0 cfs (Table 1, Figure 3). The decrease in discharge suggests the shallow water table surface elevation is lower than the stream elevation in the measured stream reaches and/or a downward gradient exists between the stream channel and the unconfined aquifer along the measured reaches.

Deadman Creek and Sand Creek originate in the Sangre de Cristo Mountains where the stream channels are steep and narrow, flow velocity is high, depth to bedrock is shallow, and infiltration rates are small. At the mountain front the stream channels transition from shallow bedrock to alluvial fans where the land slope decreases, depth to ground water is greater, channel bed material is coarse, and infiltration rates are greater. From the alluvial fans the channels transition into the sand sheet where the land slope and depth to ground water are less, allowing the streams to fully saturate the substrate between the channel bottom and the unconfined aquifer, resulting in lower infiltration rates than on the alluvial fans.

An exception to this was found within the final 0.4 miles of the measured reach on Sand Creek, where surface flow emerged from a relatively narrow channel and terminated in a broad sandy channel. The infiltration rate within this reach increased from about 1.1 cfs/mile to about 13 cfs/mile. In this situation the substrate has enough capacity to infiltrate the entire stream flow.

Table 1. – Summary of measured discharge and rate of change in discharge per stream mile for Deadman Creek and Sand Creek.

Station ID	Measured Discharge (cfs)	Change in Discharge Between Stations (cfs)	River Mile (miles)	Distance Between Stations (miles)	Rate of Change in Discharge per stream mile Between Stations (cfs/mile)	Setting
<b>Deadman Creek</b>						
DC #1	8.4	—	7.2	—	—	Alluvial Fan
DC #2	5.3	-3.1	5.9	1.3	-2.4	Alluvial Fan
DC #3	3.6	-1.7	5.0	0.9	-1.9	Sand Sheet
DC #4	1.4	-2.2	1.0	4.0	-6.6	Sand Sheet
Total Change	—	-7.0	—	6.2	-1.1	
<b>Sand Creek</b>						
SC #1	13	—	5.7	—	—	Alluvial Fan
SC #2	9.6	-3.4	4.3	1.4	-2.4	Alluvial Fan
SC #3	6.3	-3.3	1.9	2.4	-1.4	Dune Sand Sheet
SC #4	5.5	-0.8	1.2	0.7	-1.1	Dune Sand Sheet
SC #5	0.0	-5.5	0.6	0.4	-13	Dune Sand Sheet
Total Change	—	-13	—	4.9	-2.6	

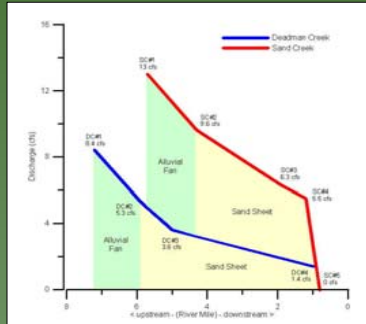


Figure 3. Discharge versus river mile for Deadman Creek and Sand Creek.

### Big Spring Creek and Little Spring Creek

From upstream to downstream along the 4.7-mile measured reach of Big Spring Creek the average discharge increased from 0.2 cfs to 5.4 cfs and the average discharge along the 1.4-mile measured reach of Little Spring Creek remained essentially unchanged at 1.1 to 1.2 cfs (Table 2, Figure 4). The increase in discharge on Big Spring Creek suggests the shallow water table surface elevation is higher than the stream elevation in the measured stream reach. The approximately equal discharge on Little Spring Creek suggests the shallow water table surface and the surface of the stream are near equilibrium in the measured stream reach.

Big Spring Creek and Little Spring Creek originate on the lowermost extent of the sand sheet where the land surface intercepts the ground water. Ground water sapping has caused headward erosion of the streams, extending the springline several miles up gradient and into the sand sheet. As a result of the high water table, Big Spring Creek is a gaining stream throughout its measured reach and Little Spring Creek neither gains nor loses appreciable flow along its measured reach.

Table 2. – Summary of measured discharge and rate of change in discharge per stream mile for Big Spring Creek and Little Spring Creek.

Station ID	Measured Discharge (cfs)	Change in Discharge Between Stations (cfs)	River Mile (miles)	Distance Between Stations (miles)	Rate of Change in Discharge per stream mile Between Stations (cfs/mile)	Setting
<b>Big Spring Creek</b>						
BS #1	0.2	—	4.7	—	—	Sand Sheet
BS #2	3.9	+3.7	3.1	1.6	+2.3	Sand Sheet
BS #3	5.4	+1.5	0.01	3.1	+0.5	Sand Sheet
Total change	—	+5.2	—	4.7	+1.1	
<b>Little Spring Creek</b>						
LS #1	1.1	—	3.9	—	—	Sand Sheet
LS #2	1.2	+0.1	3.3	0.6	+0.2	Sand Sheet
LS #3	1.2	0.0	2.6	0.6	0.0	Sand Sheet
Total Change	—	+0.1	—	1.4	+0.1	

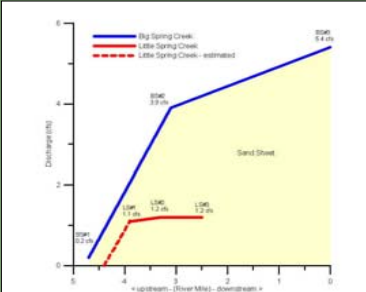


Figure 4. Discharge versus river mile for Big Spring Creek and Little Spring Creek.

## Conclusions

For the period of September 22, 23, and 24, 2004, from upstream to downstream within the measured reaches, Deadman and Sand Creeks were losing streams (Table 1), Big Spring Creek was a gaining stream (Table 2), and Little Spring Creek neither gained nor lost discharge (Table 2). Except for the terminus of Sand Creek, infiltration rates for Deadman Creek and Sand Creek were higher on the alluvial fans than on the sand sheet.

The results of the September 2004 seepage investigation demonstrate the relationship between surface flow and the underlying depth to ground water in the San Luis Valley. Along the margins of the valley, where the depth to ground water is greater, there is a zone of ground water recharge, and near the center of the valley, where the depth to ground water is smaller, there is a zone of ground water discharge.

## References

HRS Water Consultants, Inc., 2006, Numerical Ground Water Model of Great Sand Dunes National Park and Preserve, Colorado, HRS Water Consultants, Inc., Lakewood, Colorado, 122 p.  
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